**PARKme System**

**Systems Engineering Management Plan (SEMP)**

George Mason University

SYST 798, Prof. Speller

**Craig Emmerton**

**Earl Morton**

**Shaun McDonald**

**David Richards**

**Nikki Torres-Avila**

Table of Contents

1.0 SCOPE 3

1.1 Identification 3

1.2 Purpose 3

1.3 Document overview 3

1.4 Relationship to other standards and plans 4

1.5 Systems Engineering Management Group 4

2.0 APPLICABLE DOCUMENTS 4

2.1 Requirements documents 4

2.2 Specifications 4

2.3 Manuals 4

2.4 Program Plans 5

2.5 Other Documents 5

3.0 TECHNICAL PROGRAM PLANNING AND CONTROL 5

3.1 Organizational Responsibilities and Authority for System Engineering Management 5

3.1.1 Organization 5

3.1.2 Systems Engineering Management Process Group 5

3.2 Purpose and Activities 6

3.2.1 Responsibilities for design and development 6

3.3 Objectives 6

3.4 Development of Contract Work Breakdown Structure (CWBS) and Specification Tree 6

3.5 Program Risk Analysis 7

3.6 System Test Planning 8

3.6.1 HWCI and CSCI Testing 8

3.6.2 HWCI and CSCI Integration Testing 9

3.6.3 System/Subsystem Performance and Integration Testing 9

3.6.4 Regression Testing 9

3.6.5 Final Acceptance Testing 9

3.7 Decision and Control Processes 9

3.7.1 Interface control 10

3.8 Technical Performance Measurement 10

3.8.1 Parameters 11

3.8.2 Planning 11

3.8.3 Implementation of a TPM 11

3.8.4 Relating TPM to Cost and Schedule Performance Measurement 11

3.8.5 Status Reporting of TPM 11

3.9 Formal Technical Reviews (Design Reviews) 12

3.9.1 Preliminary Design Review (PDR) 12

3.9.2 Critical Design Review (CDR) 13

3.10 Supplier/Vendor Reviews 13

3.11 Work Authorization 14

3.12 Documentation control 14

3.13 Approval Procedure and Responsibilities 14

3.14 Continuous Acquisition and Life Cycle Support (CALS) 14

4.0 SYSTEM ENGINEERING PROCESS 14

4.1 Mission Analysis 14

4.1.1 System and User Needs Analysis 15

4.1.2 Products from Analysis 15

4.1.3 Customer Needs 15

4.2 Functional Analysis 15

4.2.1 Functional Analysis Procedure 15

4.2.2 Value Engineering 16

4.2.3 System Design 16

4.2.4 Interface Design and Management 16

4.3 Allocation 16

4.4 Synthesis 17

4.5 Logistic Engineering 17

4.5.1 Logistic Engineering Analysis 17

4.5.1.1 Maintenance Engineering Analysis 17

4.5.1.2 Logistic Support Modeling 17

4.6 Life Cycle Cost Analysis 18

4.7 Optimization 18

4.7.1 Trade-Off Studies 18

4.7.2 System/Cost Effective Analysis 18

4.8 Production Engineering Analysis 18

4.9 Generation of Specifications 19

4.9.1 Specification Maintenance 19

4.9.2 Specification Authentication 19

4.9.3 Specification Release and Approval 19

5.0 ENGINEERING SPECIALTY INTEGRATION 19

5.1 Software Development Plan 19

5.2 User Computer Interface Design Program Plan 20

5.3 Reliability, Availability and Maintainability 20

5.4 Engineering Program Plan 21

5.5 Hardware Development Plan 21

5.6 System Test Plan 22

5.7 Environmental, Safety and Occupational Health (ESOH) 22

5.8 Data Management Plan 23

5.9 Earned Value Management Plan 23

APPENDIX A - ACRONYMS 25

1.0 SCOPE

1.1 Identification

The Systems Engineering Management Plan (SEMP) governs the systems engineering activities to support the development of all the PARKme products and associated interfacing systems.

This document meets the requirement, as requested by the PARKme Statement of Work (SOW) and System Specification to the MIL-STD-499 standard to create a System Engineering Management Program Plan for the PARKme project.

1.2 Purpose

The purpose of this document is to identify and describe the overall tasks, as defined in SOW, principles and objectives for System Engineering Management (SEM) to be used during the system life cycle of the PARKme System and its comprising subsystems, Computer Software and Hardware Configurations Items, manual of operations, and supporting equipment for the PARKme project. The SEMP shall accommodate and be updated to reflect changes to the actual timing of System Engineering activities, reviews, and decisions to be adopted and implemented for the PARKme Project.

1.3 Document overview

The following presents a summary of each section included in this System Engineering Management Plan.

* Section 1 introduces the objectives summarizes the contents of this document
* Section 2 lists the referenced documents
* Section 3 outlines and describes the organizational structure and the resources responsible for executing the activities in this plan
* Section 4 provides the System Engineering Process to be used for the PARKme project
* Section 5 defines the integration and coordination of the program efforts
* Section 6 defines the terms, acronyms and abbreviation used in this document

The SEMP document will be placed under change control upon its initial release

1.4 Relationship to other standards and plans

The SEMP is to be complimentary to and used in conjunction with the company policies and processes, development plans, system engineering processes, software development plans, configuration management plans, procedures, standards, and other processes and plans.

1.5 Systems Engineering Management Group

The Systems Engineering Management Group shall be responsible of creating, development and maintenance of the Project Management System documents (Systems Engineering Plan, Configuration Management Plan, Software Development Plan, System Test Plan, and Risk Management Plan), evaluation of engineering output products (documentation, standards), ensuring standardization of methods and tools being used or purchased for the PARKme project.

2.0 APPLICABLE DOCUMENTS

The following documents are standards and guidance that are applicable to this SEMP.

2.1 Requirements documents

PARKme System Requirements Document (SRD), December 2008

2.2 Specifications

Commonwealth of Virginia laws

George Mason University Parking Service’s rules and regulations

PARKme System Requirements Specification (SRS), December 2008

2.3 Manuals

Defense Acquisition Guidebook, last updated 20 December 2004

Systems Engineering Plan (SEP) Preparation Guide, OUSD (AT&L), Version 0.95 dated 22 December 2004

MIL-HDBK-61A, Military Handbook, Configuration Management Guidance

MIL-HDBK-781, DOD Handbook for Reliability Test Methods, Plans, and Environments for Engineering, Development Qualification, and Production

Risk Management Guide for DoD Acquisition, Fifth Edition, Department of Defense Acquisition University, dated June 2003

2.4 Program Plans

PARKme program plan documents shall be available from the project library maintained on the web based IDE.

* Risk Management Plan (RMP)
* Configuration Management Plan (CMP)
* A Software Development Plan (SDP)
* User-Computer Interface (UIC) Plan
* System Requirements Document (SRD) for the PARKme
* Earned Value Management Plan (EVMP)

2.5 Other Documents

IEEE 1220: Application and Management of the Systems Engineering Process

ASTM/EIA-632: Systems Engineering

IEEE/EIA 12207.0-1996, Software life cycle processes

IEEE/EIA 12207.1-1997, Software life cycle processes -Life cycle data

IEEE/EIA 12207.2-1 997, Software life cycle processes -Implementation considerations

In the event of a conflict between this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained; in which case the exemption will be identified in the text. When detailed specifications are required to meet an operational requirement, a waiver shall be obtained for their use.

3.0 TECHNICAL PROGRAM PLANNING AND CONTROL

3.1 Organizational Responsibilities and Authority for System Engineering Management

3.1.1 Organization

Systems Engineering Management is defined as part of the Engineering Management System and shall operate on conceptual levels from the managing agency, prime contractor to the suppliers.

3.1.2 Systems Engineering Management Process Group

The Systems engineering management process group shall be responsible for the preparation and maintenance of the overall project plans, standards, and procedures as defined within a SOW in accordance with the contracted design requirements specification.

3.2 Purpose and Activities

The purpose of the SEMP is to establish, identify, and define tasks (as defined in the PARKme SOW) and objectives from System Engineering Management (SEM) during the total life cycle of the system and subsystems for the PARKme project.

3.2.1 Responsibilities for design and development

The purpose of this SEMP is to identify and define tasks required to progress the operational need from concept to the deployment and operation of the System.

Systems Engineering Management is a discipline to ensure the proper control of design, development, test, and evaluation tasks required to progress from an operational need to the deployment and operation of the PARKme system by the user. It describes what is required, designed and produced, evaluating changes including effects on technical and operational performance and logistic support activities.

3.3 Objectives

The SEMP shall address all engineering topics during the total life cycle from concept to deployment. The SEMP shall also define and document the process by which the PARKme system is managed.

3.4 Development of Contract Work Breakdown Structure (CWBS) and Specification Tree

The engineering activity shall develop the technical elements of the CWBS/SOW. The Contract WBS is the approved WBS for contract-reporting purposes and its discretionary extension to lower levels by the contractor, in accordance with acquirer direction and the contract work statement. It includes all the elements for the products (hardware, software, data, or services), which are the responsibility of the contractor.

All of a contractor's technical planning must be carefully integrated. This should be accomplished through coordination of IPTs during their various planning efforts and may be documented as a part of the Systems Engineering Management Plan (SEMP).

The completed Program-unique specifications can be organized into a specification tree. A specification tree structures the performance parameters for the system or subsystems being developed and represents the next logical use of the Design (or Physical) Architecture. The specification tree subdivides the system into its component elements and identifies the performance objectives of the system and its elements. The performance characteristics are explicitly identified and quantified. Traceability of top-down technical requirements is maintained through the specification tree.

The specifications shall as a minimum comprise:

* System Specification and various component parts which define the Design
* Requirements and Component baselines
* System/Subsystem Specification (s);
* Interface Control Drawing Documentation
* HWCI Development Specifications (PIDS, CIDS)
* CSCI Software Requirements Specifications
* CSCI Interface Requirements Specifications
* CSCI Software Product Specifications
* HWCI Product Specifications (C/PIPFS function and fabrication)
* Acceptance test procedure/schedule(s)

3.5 Program Risk Analysis

Risk management will be included as part of the program definition and re-definition efforts to accomplish the following objectives:

* Identify potential risks
* Assess the risks to determine their potential severity of loss and to the probability of occurrence and their impact on schedule, performance and cost.
* Manage the risk using avoidance, reduction, retention or transfer strategies.
* Create a risk mitigation plan
* A detail description of the risk management process for the PARKme project is included in PARKme Risk Management Plan (RMP).

3.6 System Test Planning

Testing and Evaluation planning shall begin early in the acquisition process. A Testability Program Plan shall be established in the program to identify the performing activity approach for implementing the test design management tasks.

The [objective](http://thesaurus.reference.com/browse/objective) of the tests and evaluations shall be:

* Testing shall ensure that system and mission objectives will not be impaired adversely by improperly specified, designed, implemented, or maintained hardware and software
* Quantitative requirements and tolerance shall be established for the technical and operational characteristics of the system elements and their capabilities
* Tests on the system shall be systematic and qualitative using test cases in the most realistic way possible.
* Test data that are instrumental to build TPM profiles shall be identified and included in program planning to maximize their utility when updating and verifying the TPMs being tracked.

As testing a system may be complex; consideration of testing using several different phases shall be adopted.

The suggested phases are:

* Configuration Items product Testing
* Prime/Critical item Integration Testing
* System/subsystem Integration and Performance Testing;
* Regression Testing

A System Test Plan and Final acceptance plan shall be prepared whenever applicable. The System Test Plan shall contain the organizations (overall and specific), activities, resources, and planning processes necessary to plan and control the test effort for the PARKme system. The Final acceptance plan shall include the approach, responsibilities, **schedule, resource, data recording, and tests for the final acceptance trials of the** PARKme **System.**

3.6.1 HWCI and CSCI Testing

All hardware and Computer Software Configuration Item shall be tested individually. It should be focused on showing that the implemented software and hardware satisfies its functional and performance requirements.

3.6.2 HWCI and CSCI Integration Testing

CSCI/HWCI testing will be conducted IAW the Software Test Plan and the applicable Software Test Description. The objective is to validate that the hardware and software components can individually be interfaced in accordance with the SRS and Interface Requirements Specification (IRS). Testing shall be to the minimum functional requirements described in an ‘Acceptance Test Procedure’ prepare for each configuration item.

3.6.3 System/Subsystem Performance and Integration Testing

System/subsystem performance testing is conducted to identify how well the system/subsystem performs the functions in relation to the system performance objectives. Its emphasis is on the final measurable performance characteristics of the system/subsystem. System software testing shall be performed in all systems/subsystems, all software and interfaces to ensure that the CSCIS as well as the system as a whole performs as defined. The purpose of integration testing is to verify functional, performance and reliability requirements placed on major design items. It identifies problems that occur when subsystems are combined.

3.6.4 Regression Testing

Regression testing is a continuous process and is performed after every release to the software and hardware. The Focus of the regression testing is always on the impact of the changes in the system. Test cases for the regression testing should be included based on the defect fixes, enhancements or changes have occurred in the PARKme system and the impact of these changes on other aspect of the system.

3.6.5 Final Acceptance Testing

The objective of the final acceptance testing is to provide confidence that the system meets business requirements to both sponsors and users. It consists of tests to determine whether the PARKme system meets the functionality, performance, quality, interface, security and safety predetermined criteria. It must occur at end of development process and should focus on testing the system and subsystem in an operational environment. The activities, objectives, organizations, and schedules shall be documented within a specific 'Test Plan' document.

3.7 Decision and Control Processes

The early identification of performance, cost and schedule problems is required and their impact on the PARKme project shall be determined. Decisions about problems and solution alternatives shall be made only after evaluating the overall benefits and impact on system effectiveness, risk, life cycle resources and customer requirements.

The decision making process is an integral part of the overall project management of the Systems Engineering Program. To enable the process to operate correctly it is necessary to establish specific procedures for dealing with changes, having the purpose of:

* Providing the relevant information for best decisions on change to be made
* Implementing decisions
* Reviewing and implementing changes in accordance with the established rules.
* Involving the use of formally constituted Design and Control Boards / Working Groups / Review Boards at the participating companies, and supplier meetings.

3.7.1 Interface control

Interface control procedures shall consist of identifying the interfaces, establishing working groups to manage the interfaces, and the group's development of interface control documentation. The interfaces shall be defined by Interface Control Documents. ICD includes interface control drawings, interface requirements specifications, and other documentation that depicts physical and functional interfaces of related or co-functioning systems or components.

When required interface control will use ICWG or a comparable integrated team. The ICWG is the traditional forum to establish the official communications link between those responsible for the design or interfacing systems or components.

The procuring agency shall identify external interfaces, and sets requirements for integrated teams.

The contracted design agent or manufacturer manages internal interfaces; plans, organizes, and leads design integrated teams; maintains internal and external interface requirements; and controls interfaces to ensure accountability and timely dissemination of changes.

3.8 Technical Performance Measurement

Technical Performance Measurement (TPM) is defined as the continuing verification of the degree of anticipated and actual achievement for technical parameters. TPMs are derived directly from Measures of Performance. TPMs confirm progress and identify deficiencies that might jeopardize fulfillment of a system requirement. Moreover, they assess values falling outside established tolerances that indicate a need for evaluation and corrective action.

TPM assesses the technical characteristics of the system and identifies problems through engineering analyses or tests, which indicate performance being achieved for comparison with performance values allocated or specified in contractual documents. TPM can provide early and continuing predictions of the effectiveness of risk-handling actions or the detection of new risks before irrevocable impacts on the cost or schedule occur.

The TPM effort shall be tailored to meet the PARKme project needs and shall be planned and executed.

3.8.1 Parameters

The TPMs must be significant qualifiers of the total system that promote or support higher-level success. They must be measurable or quantifiable, so TPM profiles can be projected over time. Data for this task may come from historical data, test planning, or contract requirements.

3.8.2 Planning

Planning for metrics should be part of the Systems Engineering Process (SEP) planning effort starting in the early phases of the life cycle. The plan should define the management approach, identify performance or other characteristics to be measured and tracked, forecast values for those performances or characteristics, determine when assessments will be done, and establish the objectives of assessment. TPM profiles are developed from historical data, test data, system engineering planning estimates, and contract requirements.

3.8.3 Implementation of a TPM

A TPM is managed by exception. In event that the reported measurement is outside a set of acceptable values that indicates a problem is occurring, a new profile shall be developed immediately. TPM reporting is analogous to a smoke alarm; if the metric is within bounds there is no alert. TPM reporting flags design deficiencies or excesses, and permits timely action to correct them.

3.8.4 Relating TPM to Cost and Schedule Performance Measurement

TPM shall be related to cost and schedule performance measurement. Cost, schedule and TPM shall be traceable to CWBS/SOW elements.

3.8.5 Status Reporting of TPM

The status of the TPMs selected shall be reported periodically to ensure that the parameters are properly measured and the resulted data is disseminated.

3.9 Formal Technical Reviews (Design Reviews)

Formal technical reviews shall be conducted in accordance with MIL-STD-1521 general and detailed requirements to assess the degree of completion of technical efforts related to major milestones before proceeding with further technical effort.

Well-timed and effective technical reviews provide visibility into the work effort that is required under the terms of the contract. Technical reviews should be scheduled when appropriate data are available not based on arbitrarily determined calendar dates. Technical reviews are event driven not time driven. Details about how and when each technical review will occur should be included in the contract.

General principles for conducting an effective technical review are presented below:

* Make sure entry criteria for the technical review have been met and that the review is event-driven not time-driven.
* Hold the review at the contractor's facilities. The contractor is responsible for conducting reviews as part of their contract and they have all the data, models, and equipment at their site.
* Designated participants should personally attend the review. You need to make sure people with the right "know-how" conduct the review so you will be able to make good decisions.
* Designated participants should include representatives from subcontractors, vendors and suppliers as necessary. All stakeholders knowledgeable in the area concerning the technical review should be present.
* Keep the review as brief and to the point as possible by following the prepared agenda.

The technical review is not only about system performance. You need to make sure that testability, producibility, and logistic support issues are addressed as well.

3.9.1 Preliminary Design Review (PDR)

The PDR shall be performed in the system integration work effort when about 15% percent of the design has been completed. The major subsystem shall be reviewed and specifications for the major subsystem shall be approved. The primary result of the PDR is the acquirer's approval of the item performance specifications for the major subsystems. This approval allows detailed design of the major subsystems to begin.

The following items should be reviewed and evaluated during the PDR:

* Subsystem item performance specifications
* Draft detail, process, and material specifications at the component level
* Design data defining major subsystems, equipment, software, and other system elements
* Analyses, reports, "ility" predictions, trade studies, support data, and design documentation
* System level TPMs to ensure they are met
* Engineering breadboards, laboratory models, test models, mockups, and prototypes used to support design
* Supplier data describing specific components

3.9.2 Critical Design Review (CDR)

The CDR shall be performed in the system integration work effort when about 85% of the design is complete. The purpose is to review and evaluate the draft detail specifications. The primary result of this formal review is the approval of the detail design.

The following items should be reviewed and evaluated during the CDR:

* Each Configuration Item (CI) when detailed design is essentially complete
* Conducted at the component level for each hardware CI before release of design to fabrication
* Conducted at the component level for each computer software CI before coding and testing
* Test plans

3.10 Supplier/Vendor Reviews

Whenever applicable, the equipment and configuration items being developed by the subcontractors/suppliers shall be formally reviewed IAW the SEMP. These reviews shall be accomplished by the acquirer or is appointed agent with the system design authority and responsibility for the subcontracted products. The appropriate monitoring and control of subcontractors and suppliers is fundamental for the successful development of the PARKme system.

3.11 Work Authorization

The WBS/CWBS identifies the organizational elements responsible for the technical program effort. The Project Management Plans describes the method for authorizing work within the PARKme project. Detailed work authorization (work orders/directives) shall be consistent, with the cost/schedule control system. It shall include technical measures of task accomplishment.

3.12 Documentation control

 All documentation, not subject to configuration management, prepared during the development of the PARKme project shall be identified and control by the specific program area. The documentation shall be reviewed and approved using the procedures described in the specific program plan.

3.13 Approval Procedure and Responsibilities

Certification of design for the PARKme system shall be required to identify the extent to which the requirements of the system/subsystem specification have been IAW with contractual requirements.

3.14 Continuous Acquisition and Life Cycle Support (CALS)

Continuous acquisition and life cycle support is an acquirer/supplier strategy for improving business efficiency by integrating processes and making them less paper intensive. Its main focus was to migrate from hard copy technical documentation to an integrated acquisition and support process. This process reviews and modifies design and engineering process to integrate other disciplines, such as producibility, reliability, maintainability and supportability into each stage of the system design and production process.

4.0 SYSTEM ENGINEERING PROCESS

4.1 Mission Analysis

The envisioned mission for PARKme is to provide current parking availability that best suits the GMU drivers’ needs.

The operational requirements, which feed the mission requirements, for PARKme, are defined in the CDD, SRD and System Specification. During the systems engineering process these requirements will be continually evaluated to ensure they meet the needs of the mission for which it was designed.

The output of the mission analysis shall verify requirements are meet or modify existing requirements to ensure successful accomplishment of the mission needs. Therefore, PARKme will follow the System Engineering (SE) process, defined later, in order to ensure requirements are satisfied, which will satisfy Mission Analysis.

4.1.1 System and User Needs Analysis

The system and user needs analysis will address capabilities as Mandatory or Preferential. The mandatory capabilities specify the minimum characteristics the system must have. When translated to requirements they should be written in “shall” and “must” statements. The preferential capabilities will identify characteristics that increase the satisfaction of the end users.

4.1.2 Products from Analysis

The expected output products from any analysis performed are as follows:

* Verifiable requirements
* Verifiable ability to accomplish Mission
* Acceptable by the user
* Ability to meet Cost, Schedule and Performance
* Metrics to support evaluation of Threshold and Objective requirements

4.1.3 Customer Needs

Engineers will initially establish bi-weekly meeting with the end users of the PARKme. Meetings will be established in order to ensure all stakeholders are in accord with the requirements and mission objectives. These meetings will ensure the users understand the product they will receive.

4.2 Functional Analysis

The Functional Analysis will be performed to ensure PARKme requirements are satisfactory for the stakeholders and feasible for design. All requirements shall follow this iterative process.

Functional Analysis execution shall cover both Primary Category and Sub-Category requirements.

4.2.1 Functional Analysis Procedure

The Functional Analysis Procedure will define a high level procedure for completing those Missions defined in section 4.1. In addition, each step will indicate if action is done manually or Software derived. Each mission is discussed separately below. Each mission assumes the PARKme is powered-up and operational.

4.2.2 Value Engineering

PARKme will utilize value engineering to explore the possible implementation of existing systems, COTS and re-usable software. The objective is to reduce cost by leveraging on legacy systems and mature technology, so that limited to no new development must be undertaken.

4.2.3 System Design

A Systems Design approach will be employed for the PARKme System for the purpose of developing an affordable and adaptable open system. This design shall employ modular design, consensus based standards for interfaces, re-usability of software, COTS and subject to validation and verification tests. All of these options will be evaluated and used towards decision for buying or making products. Employment of this approach will ensure access to the latest technologies and products, achieve interoperability, and facilitate affordable assets.

4.2.4 Interface Design and Management

An Interface Control Working Group (ICWG) will be established to ensure coordinated review of interface documents within the PARKme. The PARKme SE with the Configuration Manager serving as Secretariat will chair the ICWG. The PARKme SE manages the change process of preliminary interface engineering products before they are placed under formal configuration control. The PARKme SE also ensures sufficient review and approval of the interface documentation once it is placed under formal configuration control via the ICWG.

The interfaces for the PARKme shall be documented and managed formally. This activity will ensure compatibility between the subsystems within the PARKme product. The PARKme Requirements and Interface Control Manager shall be responsible for managing these interfaces and tracing requirements across these interfaces utilizing the Dynamic Object Oriented Requirements System (DOORS) requirements management tool.

4.3 Allocation

PARKme Allocation will focus on the Primary Category requirements and Missions. Allocations requirements shall be traceable via analysis and will indicate the expected time it takes to complete each area.

4.4 Synthesis

Synthesis verifies the original system requirements before they are released as the output to the Systems Engineering Process. In other words a product is produced.

Synthesis included the following:

* Development of schematic diagrams reflecting the architectural connectivity of each function
* Data flow diagrams
* System Test in a live environment
* Several stress periods where all functionality was exercised concurrently
* Transform PARKme Category Architectures (from functional to physical)
* Defined Alternate Concepts, Product and Process Solutions to achieve PARKme requirements
* Define/Refine Internal and External Physical Interfaces

4.5 Logistic Engineering

PARKme logistics will strive to achieve a supportable and cost effective system. By leveraging on mature technology, legacy systems, COTS and re-use both supportability and cost shall be minimized.

4.5.1 Logistic Engineering Analysis

PARKme Logistic Engineering Analysis will focus on operations and required maintenance. An operational manual will be generated in both hard and soft copies.

4.5.1.1 Maintenance Engineering Analysis

PARKme Maintenance Engineering Analysis shall be performed at certified depot facilities. The vendor shall provide the tools necessary to correct defects in a PARKme system.

4.5.1.2 Logistic Support Modeling

No logistic modeling will be required due to the mature technology utilized within the PARKme program.

4.6 Life Cycle Cost Analysis

Life Cycle Cost analyses shall be performed periodically as set forth by the PARKme PM. This analysis shall cover present one time costs and future recurring costs.

The Life Cycle Cost Analysis for the PARKme program shall utilize guidance from the National Institute of Standards and Technology (NIST) Handbook 135 “Life-Cycle Costing Manual”. A breakout cost of each component, service fees and expected logistic feeds shall be calculated for a future three-year window and maintained by the financial department.

4.7 Optimization

4.7.1 Trade-Off Studies

PARKme development will leverage trade studies, for its common features, from commercial industry. To determine a preferred alternative, effective trade studies must follow an established process using objective rating and scoring of evaluation criteria to develop a numerical score or ranking to identify the preferred alternative.

When the trade study assessment is completed, the results must be documented and presented to the organization that requested the study, for final disposition. Then the organization that requested the study accepts or rejects the trade study. If the trade study is accepted, the trade study results and the decision shall be documented and implemented for the next future build. If the results are rejected, the organization that requested the study will provide a rationale and request clarification.

4.7.2 System/Cost Effective Analysis

Cost-effectiveness analyses shall determine the cost/benefit characteristics of candidate systems approaches to assist in selecting the preferred alternatives(s). These analyses support the Systems Engineering process and are a major factor in selecting the preferred alternative(s).

4.8 Production Engineering Analysis

PARKme Production Engineering Analysis will leverage of Trade-Off Studies, system analysis, Life Cycle Cost Analysis, Testing, Product Assurance and manufacturing.

The component vendors shall utilize their internal processes to ensure success with item components. This will focus on testing and certification of all HWCI (s) and CSCI(s).

4.9 Generation of Specifications

4.9.1 Specification Maintenance

All specification shall follow strict configuration management and defined in the PARKme Configuration Management Plan (CMP). This will apply to both government and vendor generated specifications.

In addition, and non-specification documents will also be subject to the same CMP guidance.

4.9.2 Specification Authentication

The PARKme PM and SE along with each Mission Engineer shall provide approval signature for each specification. The PARKme vendors shall follow the same process for their internal documents.

Unique Identification numbering will be assigned IAW the CMP and updates will also follow guidance provided within the CMP.

4.9.3 Specification Release and Approval

Approval of all documentation releases for the PARKme system will require signature approval of both the PARKme PM and SE. This information shall be included within the documents signature page. Vendors will follow a similar process.

5.0 ENGINEERING SPECIALTY INTEGRATION

5.1 Software Development Plan

A Software Development Plan (SDP) will be generated to complement the SEMP. The SDP will manage generation of applicable software for the PARKme. The SDP will expand on the following capabilities for software development of the PARKme:

* Overview of the PARKme and document traceability to other plans such as the RMP and PAP
* Overview of the required software work
* Defines the PARKme software development activities
* Reflect schedules
* Describes the PARKme project organization

In addition to the bullets above, the SDP establishes the overall procedures, Configuration Management (CM) and initial interface testing necessary to design and develop the software for the PARKme system.

The SDP will be managed by the PARKme SE and supported by the PARKme CM group.

5.2 User Computer Interface Design Program Plan

A User-Computer Interface (UIC) shall be developed alongside the PARKme system software development. The UIC will incorporate system design features to enable interactions between the PARKme user and software interfaces. At a minimum, these include the following:

* Displays and displayed information
* Formats
* Command modes
* User-interface language
* Input devices and techniques
* Dialogs, interactions and transactions between user and PARKme

5.3 Reliability, Availability and Maintainability

Reliability, Availability and Maintainability (RAM) requirements for the PARKme will be delineated in the package System Requirements Document (SRD). The RAM requirements are stated in quantifiable, operational terms so that they can be measured during a combined Developmental Test (DT) and Operational Test (OT).

PARKme Reliability requirements are covered in two sections as follows:

* Mission reliability: Probability of carrying out a mission without a mission critical failure.
* Logistics reliability: Ability of a system to perform as designed in an operational environment over time without any failures.

PARKme Availability requirements cover the readiness of the PARKme system. Availability is a function of the ability of the system to perform without failure (reliability) and to be quickly restored to service.

Maintainability requirements address the ease and efficiency with which servicing and preventive and corrective maintenance can be conducted. This includes overall readiness, reduce maintenance manpower needs, reduce life cycle cost and to provide data essential for management. The objective is to assure attainment of the maintainability requirements of the acquisition.

Application of RAM activities during design, development and sustainment is guided by an understanding of the concept of operations and desired capabilities. Such understanding is invaluable to understanding the rationale behind RAM requirements and performance priorities. In turn, this rationale paves the way for decisions about necessary trade studies between system performance, availability, and system cost, with impact on the cost effectiveness of system operation, maintenance, and logistics support.

5.4 Engineering Program Plan

The Engineering Program Plan (EPP) identifies the activities, critical milestones, and events in relationship to SEMP and schedule control. The following events as a minimum shall be identified:

* Technical Reviews – Will be in the form of Configuration Control Boards and System Readiness Assessments (SRA)
* Software test releases – Will be provided in increments to establish software maturity and milestones after certain capabilities are satisfied
* Acceptance Tests – This will include element level tests at each software test release
* Logistic support events
* Formal Audits

This data shall be described graphically in the form of 'Systems Engineering Master Schedule (SEMS) or Integrated Master Schedule (IMS) within the SDP.

5.5 Hardware Development Plan

A Hardware Development Plan (HDP) shall be developed to complement the PARKme system software development. The HDP will incorporate system design features to enable interactions between the PARKme user, software interfaces and the hardware. At a minimum, the HDP describes the following:

* Planning Activities (Estimation, Pre-planning, Detailed Planning)
* Scheduling and Tracking
* Test Equipment List
* Decision Analysis and
* Configuration Management
* Hardware Product Evaluation
* Hardware Quality Engineering
* Hardware Delivery Plan

5.6 System Test Plan

A System Test Plan (STP) shall be developed to complement the PARKme SEMP. The STP shall identify and define the following:

* Organizations
* Activities – Entrance and Exit criteria, strategy, Plans and Procedures, reports, and certification panel
* Resources – Ranges, personnel, schedules, equipment and lab
* Planning processes.

Test plans for the PARKme subsystems during system test and life cycle shall be identified and defined in the test plan. The overall project testing structure, including the organizations, their relationship to one another and the authority and responsibility of each organization shall be provided. Test procedures will ensure all requirements are satisfied and functionality of the PARKme is demonstrated in the intended environment for its operations.

Both contractors and government testers will inspect and verify applicable test plans and procedures to ensure system level coverage.

5.7 Environmental, Safety and Occupational Health (ESOH)

System developers shall strive to eliminate or reduce ESOH risks as part of the system’s total lifecycle risk reduction strategy.

5.8 Data Management Plan

A Data Management Plan (DMP) shall be developed to complement the PARKme SEMP. Data management consists of the disciplined processes and systems used to plan for, acquire access, manage, protect, and use data of a technical nature to support the total life cycle of the PARKme system. Most of the data produced, as part of the Systems Engineering Process, is technical in nature and describes a technical result, a plan to achieve the result, and the basis for the result. Hence, the content, the control, and the archiving of the technical data shall be managed as part of the Systems Engineering Process and with the oversight of the PARKme

The PARKme SE shall be responsible for protecting system technical data, whether the data are stored and managed by the Government or by system developers.

Technical data containing information subject to restrictions are required to be protected in accordance with the appropriate guidance, contract, or agreement. When digital data are used, the data should display applicable restriction markings, legends, and distribution statements clearly visible when the data is first opened or accessed. These safeguards not only assure government compliance with use of data, they also guarantee and safeguard system developer data that are delivered to the Government, and extend responsibilities of data handling and use to parties who subsequently use the data. All technical data deliverables shall include distribution statements, and processes shall be established to protect all data which contain critical technology information, as well as assure that limited distribution data, intellectual property data, or proprietary data are properly handled during systems engineering activities – whether the data are hard copy or digital.

5.9 Earned Value Management Plan

An Earned Value Management Plan (EVMP) shall be developed to complement the PARKme SEMP. Earned Value Management (EVM) will be more effective as a program management tool if it is integrated with technical performance and if EVM processes are augmented with a rigorous SE Process. Technical areas recommended for implementing performance based earned value are as follows:

* Technical Performance Measurement (TPM)
* Progress against requirements
* Design maturity
* Systems engineering work products

There are limitations that can be overcome by integrating EVM with robust systems engineering. First, EVM is perceived to be a risk management tool. However, EVM was not designed to manage risk and does not even mention the subject.

Second, earned value is a derived measure. Consequently, its effectiveness to integrate technical and cost performance depends on its base measures and the capabilities of the SE Process that is employed on the program. Third, EVMS does not require precise, quantifiable measures. It states that objective earned value methods are preferred, but it also states that management assessment (subjective) may be used to determine the percentage of work completed. Finally, EVMS states that Earned Value is a measurement of the quantity, not quality, of work performed. Therefore, it’s imperative that Earned Value also measures the quality and technical maturity of technical work products instead of just the quantity of work.

 A robust Systems Engineering Process should provide TPMs and exit criteria for assessing technical maturity that are quantitatively linked to Earned Value.

APPENDIX A - ACRONYMS

The following are acronyms used in this document:

|  |  |
| --- | --- |
| CALS | Continuous Acquisition and Life Cycle Support |
| CDR | Critical Design Review |
| CI | Configuration Item |
| CMMI | Capability Maturity Model Integration |
| CMP | Configuration Management Plan |
| COTS | Commercial off-the-shelf |
| CSCI | Computer Software Configuration Item |
| CWBS | Contract Work Breakdown Structure  |
| DOORS | Dynamic Object Oriented Requirements System |
| DT | Developmental Test |
| EPP | Engineering Program Plan  |
| EVMS | Earned Value Management Plan |
| GMU | George Mason University |
| HDP | Hardware Development Plan |
| HWCI | Hardware Configuration Item |
| IAW | In accordance with |
| ICD | Interface Control Documents |
| ICWG | Interface Control Working Group |
| IEEE | Institute of Electrical and Electronics Engineers |
| IMS | Integrated Master Schedule |
| IPT | Integrated Product Team |
| IRS | Interface Requirements Specification |
| MTBF | Mean time between failure |
| MTTR | Mean time to recovery |
| NIST | National Institute of Standards and Technology |
| PDR | Preliminary Design Review |
| OT | Operational Test |
| RMP | Risk Management Plan |
| SDP | Software Development Plan |
| SEM | System Engineering Management |
| SEMP | System Engineering Management Plan |
| SOW | Statement of Work |
| SRA | System Readiness Assessments |
| SRD | System Requirements Document |
| SRS | System Requirements Specification |
| TPM | Technical Performance Measurement |
| UIC | User-Computer Interface |